Profile of European adults interested in internet-based personalized nutrition: The Food4Me Study

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Title

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Author names

Katherine M. Livingstone, Carlos Celis-Morales, Santiago Navas-Carretero, Rodrigo San-Cristobal, Clare B. O'Donovan, Hannah Forster, Clara Woolhead, Cyril F.M. Marsaux, Anna L. Macready, Rosalind Fallaize, Silvia Kolossa, Lydia Tsirigoti, Christina P. Lambrinou, George Moschonis, Magdalena Godlewska, Agnieszka Surwiłło, Christian A. Drevon, Yannis Manios, Iwona Traczyk, Eileen R. Gibney, Lorraine Brennan, Marianne C. Walsh, Julie A. Lovegrove, J. Alfredo Martinez, Wim H. Saris, Hannelore Daniel, Mike Gibney, John C. Mathers, on behalf of the Food4Me Study.

Author affiliations

Human Nutrition Research Centre, Institute of Cellular Medicine, Newcastle University, Newcastle Upon Tyne, UK (KML, katherine.livingstone@newcastle.ac.uk; CCM, carlos.celis@newcastle.ac.uk; JCM, John.Mathers@newcastle.ac.uk)

Center for Nutrition Research, University of Navarra, Pamplona, Spain; CIBER Fisiopatología Obesidad y Nutrición (CIBERobn), Instituto de Salud Carlos III, Madrid, Spain (SNC, snavas@unav.es; RSC, rsan.1@alumni.unav.es; JAM, jalfmtz@unav.es)

UCD Institute of Food and Health, University College Dublin, Belfield, Dublin 4, Republic of Ireland (CBD, cbhodonovan@hotmail.com; HF, hannah.forster@ucdconnect.ie; CW, clara.woolhead@ucdconnect.ie; EG, eileen.gibney@ucd.ie; LB, lorraine.brennan@ucd.ie; MCW, marianne.walsh@ucd.ie; MG, mike.gibney@ucd.ie)

Department of Human Biology, NUTRIM School for Nutrition, Toxicology and Metabolism, Maastricht University Medical Centre, Maastricht, the Netherlands (CFMM, c.marsaux@maastrichtuniversity.nl; WHMS, w.saris@maastrichtuniversity.nl)

Hugh Sinclair Unit of Human Nutrition and Institute for Cardiovascular and Metabolic Research, University of Reading, Reading, UK (ALM, a.l.macready@reading.ac.uk; RF, R.Fallaize@pgr.reading.ac.uk; JAL, j.a.lovegrove@reading.ac.uk)

ZIEL Research Center of Nutrition and Food Sciences, Biochemistry Unit, Technische Universität München, Germany (SK, silvia.kolossa@tum.de; HD, hannelore.daniel@tum.de)

Department of Nutrition and Dietetics, Harokopio University, Athens, Greece (LT, tsirigoti.lydia@gmail.com; CPL, cplambrinos@gmail.com; GM, gmoschi@hua.gr; YM, manios@hua.gr)

National Food & Nutrition Institute (IZZ), Poland (MG, mgodlewska@izz.waw.pl; AS, asurwillo@izz.waw.pl; IT, itraczyk@izz.waw.pl)

Department of Nutrition, Institute of Basic Medical Sciences, Faculty of Medicine, University of Oslo, Oslo, Norway (CAD, c.a.drevon@medisin.uio.no)

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Corresponding author; request for reprints

Professor John C. Mathers

Human Nutrition Research Centre

Institute of Cellular Medicine

Newcastle University

Biomedical Research Building

Campus for Ageing and Vitality

Newcastle upon Tyne

NE4 5PL

john.mathers@newcastle.ac.uk

Tel: +44 (0) 1912481133 Fax: +44 (0) 1912481101

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Purpose

Personalised intervention may have greater potential for reducing the global burden of non-communicable diseases and for promoting better health and wellbeing across the life-span than the conventional "one size fits all" approach. However, the characteristics of individuals interested in personalised nutrition (PN) are unclear. Therefore, the aim of this study was to describe the characteristics of European adults interested in taking part in an internet-based PN study.

Methods

Individuals from seven European countries (UK, Ireland, Germany, the Netherlands, Spain, Greece and Poland) were invited to participate in the study via the Food4Me website (http://www.food4me.org). Two screening questionnaires were used to collect data on socio-demographic, anthropometric and health characteristics as well as dietary intakes.

Results

A total of 5662 individuals expressed an interest in the study (mean age 40 ± 12.7; range 15-87 years). Of these 64.6% were female and 96.9% were Caucasian. Overall, 12.9% were smokers and 46.8% reported the presence of a clinically diagnosed disease. Furthermore, 46.9% were overweight or obese and 34.9% were sedentary during leisure time. Assessment of dietary intakes showed that 54.3% of individuals reported consuming at least 5 portions

of fruit and vegetables per day, 45.9% consumed more than 3 servings of wholegrains and 37.2% limited their salt intake to less than 5.75g per day.

Conclusions

Our data indicate that individuals volunteering to participate in an internet-based PN study are broadly representative of the European adult population, most of whom had adequate nutrient intakes but who could benefit from improved dietary choices and greater physical activity. Future use of internet-based PN approaches is thus relevant to a wide target audience.

Trial registration – Clinicaltrials.gov NCT01530139 (http://clinicaltrials.gov/show/NCT01530139)

Key Words – Personalised nutrition, European profile, tailored intervention, internet-based, randomized controlled trial.

Introduction

Non-communicable diseases (NCD), are the leading cause of death and are responsible for 36 million global deaths annually [1]. With modifiable risk factors estimated to account for over 80% of premature deaths from CVD and cerebrovascular disease [2], lifestyle-based interventions, including diet and physical activity, have been identified as an effective strategy for minimising the burden of NCD [3]. However, realising this potential will require the development, testing and implementation of much more effective behaviour change interventions than are used conventionally [4-6]. To achieve such changes, interventions will need to move from a conventional "one size fits all" approach to more predictive, personalised, preventive and participatory interventions [7]. The concept of personalised nutrition (PN) has been developed based on emerging understanding of the interactions between diet, phenotype and genes on health [8]. In contrast with conventional 'one-size fits all' approaches to dietary intervention, PN aims to provide advice on an individual (or group) basis that is tailored to specific needs based on knowledge of current diet and phenotypic and/or genotypic information. However, public acceptability will be a key prerequisite for the successful implementation of PN [9]. A survey of 6000 individuals across eight European countries found that 27% of individuals were willing to undertake genetic testing for the purpose of PN [10]. The internet offers substantial opportunities for cost-effective implementation of PN intervention strategies with the potential for scalability and reach [6]. With an estimated 85% of the European population now using the internet[11], knowledge of the characteristics of individuals who would be interested in receiving PN advice via the internet would be valuable for planning future lifestyle-based interventions aiming to reduce health inequalities and to improve overall public health.

The Food4Me Proof of Principle (PoP) Study is an internet-based randomized controlled trial conducted across seven European countries designed to compare the effects of different levels of PN on dietary behaviour and other health-related outcomes [12]. The present paper describes the characteristics of individuals interested in internet-based PN advice who were screened for inclusion in the Food4Me PoP Study.

Materials and methods

The present paper outlines responses to the screening questionnaires provided by individuals who indicated an interest in participating in the Food4Me PoP randomized controlled trial. The protocol for the Food4Me PoP Study has been published elsewhere [12].

Participant recruitment

Recruitment was conducted between July 2013 and February 2014 across seven European countries, via the internet, to emulate an internet-based PN service. Participants indicated their interest in joining the study by voluntarily registering their details on the Food4Me website (http://www.food4me.org/), which was set up for the purposes of the study (see Online Resource 1, Figure S1). The Food4Me PoP recruitment sites were as follows: University College Dublin (Ireland); Maastricht University (the Netherlands); University of Navarra (Spain); Harokopio University (Greece); University of Reading (United Kingdom; UK); National Food and Nutrition Institute (Poland); Technische Universität München (Germany).

Local and national advertising of the study via the internet, radio, posters, e-flyers, social media and word of mouth were used to aid recruitment (see Online Resource 1, Figure S2).

Screening Questionnaires

Once participants registered their details on the Food4Me website and consented to take part in the study, they were assigned a unique username and password and asked to complete two online screening questionnaires.

First Screening Questionnaire

The first screening questionnaire contained nine items on one screen. Individuals were asked to provide their age and sex, as well as information on internet access, pregnancy, food intolerances and allergies, since these data were used as exclusion criteria for the later randomized controlled trial (RCT).

Second Screening Questionnaire

Participants eligible for inclusion in the RCT completed a second online questionnaire. The primary purpose of this questionnaire was to collect detailed socio-demographic, health, anthropometric and dietary data. Following completion of this questionnaire, participants were asked to complete a screening food frequency questionnaire (FFQ) to estimate habitual dietary intake. The online Food4Me FFQ included 157 food items consumed frequently in each of the seven recruitment countries and intakes of foods and nutrients were computed in real time using a food composition database. The FFQ and food composition database were developed and validated specifically for the Food4Me PoP study

[13,14]. In the present analysis, dietary intakes of foods and food groups were assessed against six dietary recommendations: eat at least 5 portions of fruit and vegetables every day; eat at least 3 portions of wholegrain products every day; eat at least 1 portion of oily fish per week; eat less than 3 portions of red meat and processed meat per week; consume less than 5.75g/day of salt and consume less than 10% energy from sugars.

Anthropometric measurements and physical activity

Body weight and height were self-measured and self-reported by participants via the internet. Occupational and non-occupational physical activity were self-reported via the internet prior to completion of the FFQ. Participants were asked to categorise their occupational physical activity as light (e.g. administrative and managerial), moderate (e.g. sales worker) or heavy (e.g. equipment operator) and their non-occupational physical activity as sedentary (little walking/cycling/exercise), moderately active (intense exercise lasting 20-45 minutes at least twice per week) or very active (intense exercise lasting at least an hour per day).

Ethical approval and participant consent

The Research Ethics Committees at each University or Research Centre delivering the intervention granted ethical approval for the study. The Food4Me trial was registered as a Randomized Clinical Trial (NCT01530139) at Clinicaltrials.gov. All participants who expressed an interest in the study were asked to sign online consent forms at two stages in the screening process: prior to submitting any details and prior to the screening FFQ. These consent forms were automatically directed to the local study investigators to be counter-signed and archived. All Ethical Committees accepted an online informed consent

procedure, except for The Netherlands and Germany whose ethics committees requested an additional written informed consent form for participants who registered to participate in the study. In the latter countries, hard copy consent forms were sent by post to the respective recruitment centres. Personal information from respondents was stored on a secure, password-protected server.

Statistical analysis

Data were analysed using Stata (version 13; StataCorp., College Station, TX, USA). Results from descriptive analyses are presented as means and SD for continuous variables or as percentages for categorical variables. Chi squared tests and multinomial regression analyses were used to test for significant differences across categorical variables. For multinomial comparisons across countries, the overall average was used as the reference group. ANOVA and Fisher-Hayter pairwise comparisons were used for continuous variables. Results were deemed significant at $P<0.05$.

Results

Participant characteristics at first screening

A total of 5562 individuals registered their name and contact details on the Food4Me website (http://www.food4me.org/) and a total of 5442 individuals completed the first screening questionnaire (Tables 1 and 2). The completion rate for this questionnaire was 88.6% with 120 Dutch participants choosing to not proceed to the first screening

questionnaire. Of the individuals who consented to participate in the study, 64.6% were female and 64.0 % were below 45 years of age.

A total of 1631 individuals were ineligible for the subsequent RCT based on the first screening questionnaire. This was due mainly to having a food allergy or intolerance and/or not completing the second screening questionnaire (Figure 1). Reported food allergies and intolerances were more common among females than males (Table 1). Inter-country differences for the prevalence of therapeutic diets, food allergies and intolerances are presented in Table 2. The most common means of recruitment to the study was through magazines and newspaper articles, followed by word of mouth, but this varied by country and age group. Social media were responsible for recruiting more than three times as many individuals under, than over, the age of 45 years (Table 1).

Participant characteristics at second screening

Characteristics of the 3811 subjects who completed the second screening questionnaire are summarised in Tables 3 and 4. The completion rate for this questionnaire was 68.5% with 1751 individuals choosing to not proceed to the second screening questionnaire. The profile of these participants was similar to that of the whole cohort who expressed an initial interest in the Food4Me study: 62.4% were female and 62.8% were younger than 45 years of age. The percentage of females at this screening stage was more comparable across countries (range 56.6- 73.8%) than at the initial screening (range 48.7 -77.3%). We observed that 96.9% of the participants were Caucasian.

171 Obesity prevalence and reported health status

172 Nearly half (46.9%) of participants were classified as overweight or obese but this
173 proportion varied considerably by sex, age and country (Table 3 and 4). As summarised in
174 Tables 5 and 6, nearly half (44.6%) of individuals reported that they were on medication:
175 33.2% on prescribed and 11.5% non-prescribed medication. Prescribed and non-prescribed
176 medication use was higher in females than males (38% vs. 25% and 13.1% vs. 8.7%
177 respectively) and higher in individuals over the age of 45 years (44.8% vs. 26.3% and 14.5%
178 vs. 9.6% respectively; see Online Resource 1 Table S1). Prescribed medication use was
179 higher in Germany (38.5%) and The Netherlands (47.4%) and lower in Spain (28.4%),
180 compared with overall, whereas non-prescribed medication use was higher in Poland
181 (17.9%) and Germany (16.3%), compared with overall (see Online Resource 1 Table S2). In
182 addition, 47.3% of individuals indicated that they were suffering from one or more clinically
183 diagnosed diseases. Overall, 19.9% of individuals reported having an allergy, with the
184 highest prevalence in Spain (26.9%) and lowest in Ireland (13.3%). Furthermore, 9.3% of
185 individuals reported high blood pressure which was more common in males than in females
186 (12.6% vs. 7.3%), and among individuals over, than under, the age of 45 years (18.9% vs.
187 3.6%; see Online Resource 1 Table S1). The prevalence of type I or type II diabetes was only
188 0.9 %, but was higher in individuals over, than under, the age of 45 years (1.8% vs. 0.4%). On
189 average, 12.9% of individuals were current smokers and smoking prevalence was more than
190 five times higher in Greece than in the UK (see Online Resource 1 Table S1).

191

192 Reasons for interest in the Food4Me PoP Study

193 Nearly three quarters of the individuals (75.4%) indicated an interest in the Food4Me study
194 because they were interested in PN, while 80.7% were interested in learning about what
195 foods were best for them (Table 4). These results varied little by sex but slightly more
196 individuals under, than over, the age of 45 years were interested in PN (Table 3). Just over
197 half of individuals (50.6%) indicated that their reason for registering with the study was due
198 to a desire to lose (48.8%) or, much less commonly, gain (1.9%) weight. When asked if their
199 interest was due to concerns for their health and well-being, up to 87.5% of the participants
200 selected this option (Table 4). The proportion of individuals interested in health and well-
201 being did not vary much by sex but was slightly higher in individuals over, than under, the
202 age of 45 years (Table 3).

203

204 Dietary intake and physical activity characteristics

205 A total of 2764 individuals provided complete data on dietary intake and PA at screening.
206 The completion rate for this questionnaire was 77.3%, with 811 individuals choosing not to
207 complete the screening FFQ after providing a second consent. Comparisons of screenees'
208 dietary intakes with current dietary recommendations in Europe that were used in this
209 study are presented in the Online Resource 1 Table S3, Figure S3-S6. Regarding fruit and
210 vegetables intake 54.3% of individuals reported consuming at least five portions per day and
211 the mean intake of the cohort (651.4g, SD 488.6) was greater than the WHO/FAO
212 recommended minimum of 400g per day [15]. Just under half of participants (45.9%)
213 consumed at least three portions of wholegrains per day. A third of participants (36.3%)
214 consumed more than one portion of oily fish per week. Two thirds (66.2%) of individuals
215 consumed less than three portions (450g) of red or processed meat weekly. Furthermore,

only 37.2% of individuals consumed less than 5.75g of salt per day (mean 7.56 g, SD 4.88). Overall, only 2.1% of participants consumed less than 10% energy from sugars. Nearly three quarters (72.9 %) of individuals reported being in light/sedentary occupations, whereas only 34.9% of individuals were sedentary during leisure time (Table 3 and 4).

Discussion

Main findings

The present paper characterised the 5562 individuals who registered interest in participating in the Food4Me PoP PN intervention. Our main findings are that the European individuals interested in participating in an online PN study were not restricted to one specific group of individuals. Potential volunteers in the Food4Me PoP Study were broadly representative of the European adult population, most of whom had adequate nutrient intakes but could benefit from improved dietary choices and more physical activity to reduce their risk of common non-communicable diseases [16].

Comparison with other studies

The Food4Me PoP study is the first pan-European internet-based PN intervention study to collect detailed characteristics of individuals who would be interested in using such a service. However, a recent study across six European countries indicated that individuals over 65 years of age would be more interested in undertaking a genetic test for the purpose of PN than adults aged 25 to 34 years (55% vs. 28.5%) [10]. Our findings identified that interest in PN was a strong motivator for participating in the study, and that this was

239 comparable across ages, sexes and countries. Stewart-Knox *et al.* [10] found that slightly
240 more (2.2%) females than males would be interested in having a genetic test done for the
241 purposes of PN. Our findings confirm these results and suggest that females are more
242 interested in participating in nutrition interventions [17], including those delivered via the
243 internet [18]. Furthermore, we observed that females were more likely than men to be
244 interested in participating in this study because of a desire to lose weight.

245 The percentage of overweight adults in different European countries ranges between 30%
246 and 70% [19] and the prevalence of obesity in Europe is between 4% and 36.5%, with higher
247 prevalence in Central, Eastern, and Southern Europe than in Western and Northern Europe
248 [20]. Recent estimates from the Organisation for Economic Co-operation and Development
249 suggest that the average prevalence of obesity among EU adults is 16.6% [21], which is
250 similar to the prevalence of obesity in individuals who registered to participate in the
251 present study (15.7%).

252 There is strong evidence in support of an inverse relationship between PA and CVD risk [22].
253 Despite this, according to the WHO, 69% of European adults fail to achieve at least half an
254 hour of moderate-intensity PA on most days of the week [23]. Our data confirm these
255 trends in the work place, with only 27.1% of individuals being moderately active at work,
256 but suggest that during leisure time, 65.1% of individuals undertake intense exercise lasting
257 at least 20-45 minutes at least twice per week.

258 Our results suggest that less than half of screenees adhered to most of the major European
259 food-based dietary recommendations. This is consistent with the most recently available
260 EU-wide data which show that mean intakes of fruit and vegetables in Germany (371g/day),
261 Ireland (355g/day), the Netherlands (359g/day) and the UK (343g/day) [24] are less than the
262 recommended 400g/day (equivalent to 5 portions). Although we found that mean fruit and

vegetable intake was greater than 400g, it should be noted that these estimates of fruit and vegetable intakes were obtained using a 157 item FFQ [14] and there is evidence that FFQs may over-estimate dietary intakes [25], especially when they include larger numbers of food items [26]. Importantly, the FFQ used in the present study was validated against a four-day weighed record [13,14]. Recent country-specific Nutrition, Physical Activity and Obesity reports by the WHO suggest that, with the exception of Greece (data unavailable), mean salt intake is in excess of 5.75g per day across all six countries that provided participants for the present study[16]. These data are in line with our findings, where reported mean salt intakes ranged between 6g in Greece and 8.3g in The Netherlands. The current UK and WHO draft recommendations to limit sugars intake to less than 10% energy [27,28] were met by very few of our participants and only one individual out of the 5562 screenees would meet the recent proposal to limit sugars intake to less than 5% energy. In addition, the reported mean percentage energy from sugars in our study (21.4%) is comparable with the recent estimate of 19.1% for the UK from the National Diet and Nutrition Survey [29]. Overall, our observations suggest that the dietary inadequacies of the individuals interested in PN in the present study are comparable with those of the wider European population.

Individuals with ill-heath, or with a food allergy or intolerance, may benefit from PN [10]. We found that 12.4 % of the screenees declared a food allergy or intolerance. This prevalence is comparable with a recent finding that, among European adults, 11.5 % self-reported the presence of a food allergy (cow's milk, egg, wheat, soy, peanut, tree nuts, fish and shell-fish) [30]. Furthermore, a large proportion of our participants reported being on medication (44.6%) or suffering from a disease (47.3%). These results are in line with data from Stewart-Knox *et al.* [10], which showed that interest in having a genetic test performed for the purposes of PN is higher in individuals with central obesity (38.4 %) and high blood

pressure (38.1 %), than individuals with no signs of the metabolic syndrome (22.1 %). These findings confirm that those interested in PN include those for whom an effective dietary and/or physical activity intervention is likely to improve their health.

Strengths and limitations

The Food4Me PoP Study data were collected from a relatively large number of European adults, with a wide age range, who demonstrated their interest in PN by registering to join the Food4Me PoP Study. The two stage consenting process enabled the capture of data on individuals who were interested in a PN service but were not necessarily eligible to be included in the subsequent RCT. These characteristics included demographic information, adiposity, habitual physical activity, disease status, prevalence of food allergies and intolerances and dietary intake. A potential limitation of the study is that our data were obtained by self-report via the internet, which may have introduced measurement error. However, there is no reason to believe that such data are more likely to be mis-reported than data collected by conventional face-to-face interview or by paper-based questionnaires [31]. The validity of internet-based, self-reported anthropometric data is high [32] and this been confirmed in the present study (Celis-Morales C *et al*., paper submitted).

Implications for health professionals

Improving diet and lifestyle behaviours is a key element in national and international strategies for reducing the risk of NCDs and improving overall health across the life-span. However, realising this potential will require the development, testing and implementation of much more predictive, personalised, preventive and participatory interventions to achieve effective behavioural changes. Moreover, using the internet as a delivery method is

311 likely to be an important route to scalable and sustainable interventions [6]. Characterising
312 those individuals who are interested in PN and its delivery via the internet will be valuable
313 information for the future design and implementation of PN interventions aiming to
314 improve health and to reduce health inequalities. The present results suggest that those
315 who registered to participate in this internet-based PN study were broadly representative of
316 the European adult population in terms of demographic, anthropometric and health
317 characteristics. Our findings provide strong evidence for the use of internet-based PN for
318 engaging individuals who would benefit from improved lifestyle behaviours and a reduction
319 in risk of obesity and NCDs.

Abbreviations

Cardiovascular disease (CVD); Food frequency questionnaire (FFQ); Non-communicable diseases (NCD); Personalized nutrition (PN); Proof of Principle (PoP); Randomized controlled trial (RCT)

Competing interests

None of the authors had a personal or financial conflict of interest.

Authors' contributions

The authors' responsibilities were as follows: YM, IT, CAD, ERG, LB, JAL, JAM, WHMS, HD, MG and JCM contributed to the research design. JCM was the Proof of Principle study leader. CCM, CFMM, HF, CBO, CW, AM, RF, SNC, RSC, SK, LT, CPL, MG, AS, MCW, ERG, LB and JCM contributed to the developing the Standardised Operating Procedure for the study. CCM, SNC, RSC, CW, CBO, HF, CFMM, AM, RF, SK, LT, CPL, MG, AS, MCW and JCM conducted the intervention. CCM, CFMM and WHMS contributed to physical activity measurements. KML and CCM drafted the paper and performed the statistical analysis for the manuscript and are joint first authors. All authors contributed to a critical review of the manuscript during the writing process. All authors approved the final version to be published.

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439

Table 1 Characteristics of individuals by sex and age; data obtained from the first screening questionnaire[1]

	Sex		P	Age		P
	Male	**Female**		**<45 y**	**≥45 y**	
Total (n)	1971	3591	-	3484	1956	-
Sex - female (%)	-	-	-	67.5	35.5	<0.001
Age (years)[2]	41.6 (13.1)	39.2 (12.4)	<0.001	32.1 (7.0)	54.2 (6.98)	0.001
Age range (years)	15-87	15-76	-	15-44	45-87	-
Pregnant (%)	-	5.0	-	5.1	0.2	<0.001
Therapeutic diet (%)	6.4	6.7	0.609	6.4	7.0	0.434
Food allergy/intolerance (%)	8.3	14.5	<0.001	12.8	11.7	0.239
Internet access (%)	99.5	99.4	0.642	99.7	99.0	0.002
Heard about Food4Me						
Word of Mouth	30.0	30.4	0.762	35.9	20.7	<0.001
Internet Search	8.5	8.2	0.671	9.4	6.6	0.001
Food4Me Website	2.5	1.9	0.188	2.0	2.4	0.349
Social Media	3.4	5.5	0.001	6.5	1.9	<0.001
Magazine/Newspaper	50.0	45.8	0.005	41.4	57.2	<0.001
TV/radio advert	1.9	2.1	0.758	1.4	3.1	<0.001
Poster/leaflet	2.2	2.5	0.477	1.8	3.3	0.001
Other	9.5	10.2	0.397	9.6	10.6	0.228

[1]Chi squared tests and ANOVA were used to test for significant differences across categorical and continuous variables respectively.

[2]Values are means ± SDs

Table 2 Characteristics of individuals by country; data obtained from the first screening questionnaire[1]

	All	Country						
		UK	IRE	GER	NED	ESP	POL	GRE
Total (n)	5562	599	586	788	721	1839	458	571
Sex - female (%)	64.6	70.6**	65.0	70.6**	48.7***	61.9*	77.3***	68.0
Age (years)[2]	40.0 (12.7)	37.2 (9.6)*	38.0 (12.4)*	44.5 (13.9)*	49.3 (13.9)*	38.4 (9.6)*	36.0 (12.6)*	37.7 (11.5)*
Age range (years)	15-87	17-87	15-72	15-80	18-79	18-78	17-73	18-70
Age categories								
<45 years (%)	64.0	70.3**	68.3*	44.5***	45.0***	76.1***	71.0**	70.6**
≥45 years (%)	36.0	29.7**	31.7*	55.5***	55.0***	23.9***	29.0**	29.4**
Pregnant (%)	3.3	2.7	2.9	2.3	0.3***	4.4*	4.2***	4.9
Therapeutic diet (%)	6.6	3.7**	6.0	2.4***	4.3*	3.7***	5.7	9.6**
Food allergy/ Intolerance (%)	12.4	15.7*	12.5	17.1***	12.8	10.1**	12.5	9.3*
Internet access (%)	99.5	100.0	99.7	99.5	99.8	99.7	99.6	97.2***
Heard about Food4Me (%)								
Word of Mouth	30.3	41.8***	43.5***	15.9***	15.8***	17.3***	67.5***	59.7***
Internet Search	8.3	15.4***	10.1	2.9***	1.7***	10.6**	12.0**	4.9**
Food4Me Website	2.1	4.1**	1.3	1.0*	3.7*	1.0**	4.4**	2.6
Social Media	4.8	8.8***	1.6*	1.7***	1.5***	5.2	3.1	10.5***
Magazine/ Newspaper	47.3	7.3***	3.6***	73.5***	76.8***	68.8***	5.7***	4.6***
TV/radio advert	2.0	0.6*	24.8***	0.4**	1.3	0.7***	0.2*	0.0
Poster/leaflet	2.4	5.4***	8.5***	0.5**	2.2	0.0	4.8**	4.7**
Other	9.9	26.6***	12.1	11.2	5.5***	3.9***	9.2	16.5***

[1]Multinomial regression analyses were used to test for significant differences across categorical variables. For multinomial comparisons across countries, the overall average was used as the reference group. ANOVA and Fisher-Hayter pairwise comparisons were used for continuous variables. Results were deemed significant at * P<0.05, ** P<0.01 and *** P<0.001.

[2]Values are means ± SDs

Table 3 Characteristics of individuals by sex and age group; data obtained from the second screening questionnaire[1]

	Sex		P	Age		P
	Male	**Female**		**<45**	**≥45**	
Total (n)	1432	2379	-	2395	1416	-
Sex - female (%)	-	-	-	63.6	60.4	0.005
Age (years)[2]	41.6 (13.1)	39.4 (12.7)	<0.001	31.9 (7.06)	54.2 (7.04)	<0.001
Age range (years)	18-80	17-76	-	17-44	45-80	-
Ethnicity (%)						
Caucasian	96.6	97.1	0.410	96.3	97.8	0.011
Asians-Chinese	0.5	0.7	0.478	0.8	0.2	0.016
Black	0.1	0.2	0.622	0.1	0.3	0.273
Mixed	1.5	1.4	0.841	1.5	1.3	0.558
Other	1.3	0.7	0.040	1.2	0.4	0.014
Anthropometrics						
Height (m)[2]	1.8 (0.1)	1.7 (0.1)	<0.001	1.7 (0.1)	1.7 (0.1)	0.7592
Weight (kg)[2]	85.2 (15.0)	68.5 (14.2)	<0.001	73.0 (16.6)	77.7 (16.1)	<0.001
BMI (kgm^2)[2]	25.0 (4.9)	26.5 (4.9)	<0.001	26.7 (4.5)	24.9 (5.1)	<0.001
BMI Classification (%)						
Under weight	0.5	3.2	<0.001	2.5	1.6	0.071
Normal Weight	40.5	57.2	<0.001	56.8	41.0	<0.001
Overweight	41.2	25.3	<0.001	27.6	37.3	<0.001
Obese	17.8	14.4	0.006	13.1	20.1	<0.001
Physical Activity (%)[3]						
Occupational						
Light	73.9	72.3	0.382	69.3	78.9	<0.001
Moderate	22.1	26.7	0.007	28.8	18.7	<0.001
Heavy	4.0	0.1	<0.001	1.9	2.4	0.375
Non-Occupational						
Sedentary	28.2	38.9	<0.001	35.8	33.6	0.235
Moderately active	54.5	51.9	0.182	50.9	56.1	0.008
Active	17.3	9.2	<0.001	13.3	10.3	0.020
Reason for interest (%)						
Personalised nutrition	76.4	73.6	0.051	76.9	72.7	0.004
Knowing what foods are best	82.9	79.3	0.026	81.8	78.8	0.007
Losing weight	42.6	52.5	<0.001	46.4	52.9	<0.001
Gaining weight	3.3	1.1	<0.001	2.5	0.9	<0.001
Concerns for health	88.0	87.2	0.465	88.9	85.1	0.001

[1]Chi squared tests and ANOVA were used to test for significant differences across categorical and continuous variables respectively.

[2]Values are means ± SDs

[3]Physical activity was estimated from the food frequency questionnaire in 2763 individuals

[6]Compared with less than 1 hour

Table 4 Characteristics of individuals by country; data obtained from the second screening questionnaire[1]

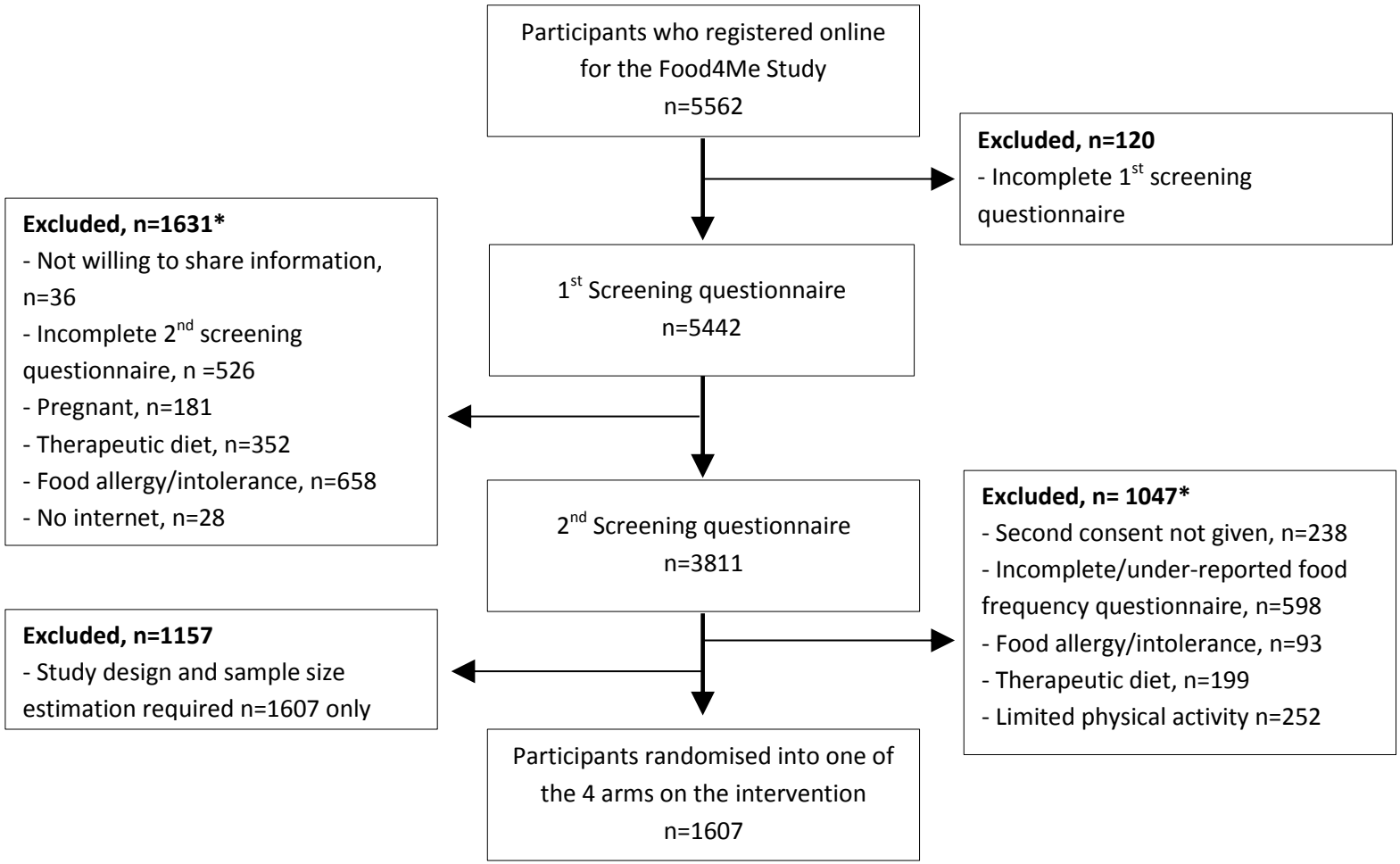
	All	Country						
		UK	IRE	GER	NED	ESP	POL	GRE
Total (n)	3811	413	405	535	511	1206	340	401
Sex - female (%)	62.4	66.8	62.7	66.4	56.6*	57.2**	73.8***	65.8
Age (years)	40.2 (12.9)	37.0 (13.3)	37.9 (12.4)	44.9 (13.9)	49.2 (14.2)	38.3 (9.47)	36.3 (12.8)	37.4 (11.6)
Age range (years)[2]	17-80	18-72	18-72	17-80	18-79	18-70	17-73	18-70
Age categories (%)								
<45 years	62.8	70.5**	67.7	44.5***	31.5***	76.0***	69.7*	69.3*
≥45 years	37.2	29.5**	32.3	55.5***	68.5***	24.0***	30.3*	30.7*
Ethnicity (%)								
Caucasian	96.9	89.6***	97.5	96.8	96.5	97.8	100	99.0*
Asians-Chinese	0.6	3.2***	1.0	0.2	0.8	0.1	0.0	0.0
Blacks	0.2	0.5	0.0	0.4	0.2	0.1	0.0	0.3
Mixed	1.4	3.2**	1.2	1.7	1.4	1.7	0.0	0.0
Other	0.9	3.6***	0.3	0.9	1.2	0.4	0.0	0.8
Anthropometrics								
Height (m) [2]	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)	1.7 (0.1)*	1.7 (0.1)*	1.7 (0.1)*	1.7 (0.1)*	1.7 (0.1)*
Weight (kg) [2]	74.8 (16.6)	73.4 (15.6)	75.2 (16.9)	73.2 (14.2)	77.3 (15.0)*	74.8 (17.9)	72.1 (16.3)	76.4 (17.8)
BMI (kgm^2) [2]	25.6 (5.0)	25.5 (5.0)	25.7 (4.9)	24.4 (3.9)*	25.4 (4.6)	25.9 (5.2)	25.1 (4.9)	26.7 (5.8)*
BMI Classification (%)								
Underweight	2.2	2.0	2.3	2.6	2.0	1.9	3.6	1.5
Normal Weight	50.9	53.0	49.1	59.1***	52.6	49.0	51.2	42.7**
Overweight	31.2	31.0	31.2	28.1	32.1	31.6	29.3	35.2
Obese	15.7	14.0	17.4	10.2**	13.4	17.5	16.0	20.6*
Physical Activity (%)[3]								
Occupational								
Light	72.9	69.5	69.6	79.0*	62.5***	82.2***	66.8*	70.6
Moderate	25.0	27.5	28.1	20.4	34.1***	16.8***	31.2*	26.0
Heavy	2.1	3.0	2.3	0.5	3.4	1.1	2.1	3.4
Non-Occupational								
Sedentary	35.0	25.5**	21.7***	31.5	23.4***	40.7**	48.6***	50.2***
Moderately active	52.9	55.0	67.6***	61.3**	64.8***	46.6**	42.1**	35.3***
Active	12.2	19.5***	10.7	7.3**	11.8	12.7	9.3	14.6
Reason for interest (%)								
Personalised nutrition	75.4	83.3***	82.0**	77.2	78.7	78.7*	55.6***	60.6***
Knowing what	80.7	73.1***	76.8	74.6**	81.0**	87.7***	86.8**	73.6**

foods are best								
Losing weight	48.8	44.6	47.7	45.2	36.6***	51.2	53.2	63.3***
Gaining weight	1.9	1.9	1.0	2.1	1.2	2.3	2.4	1.8
Concerns for health	87.5	92.5**	90.6	81.1***	76.5***	91.0**	90.6	88.5

[1]Multinomial regression analyses were used to test for significant differences across categorical variables. For multinomial comparisons across countries, the overall average was used as the reference group. ANOVA and Fisher-Hayter pairwise comparisons were used for continuous variables. Results were deemed significant at * P<0.05, ** P<0.01 and *** P<0.001.

[2]Values are means ± SDs

[3]Physical activity was estimated from the food frequency questionnaire in 2763 individuals



* Total number of participants reporting one or more exclusion criteria

Fig 1. Food4Me Proof of Principle Study flow-chart

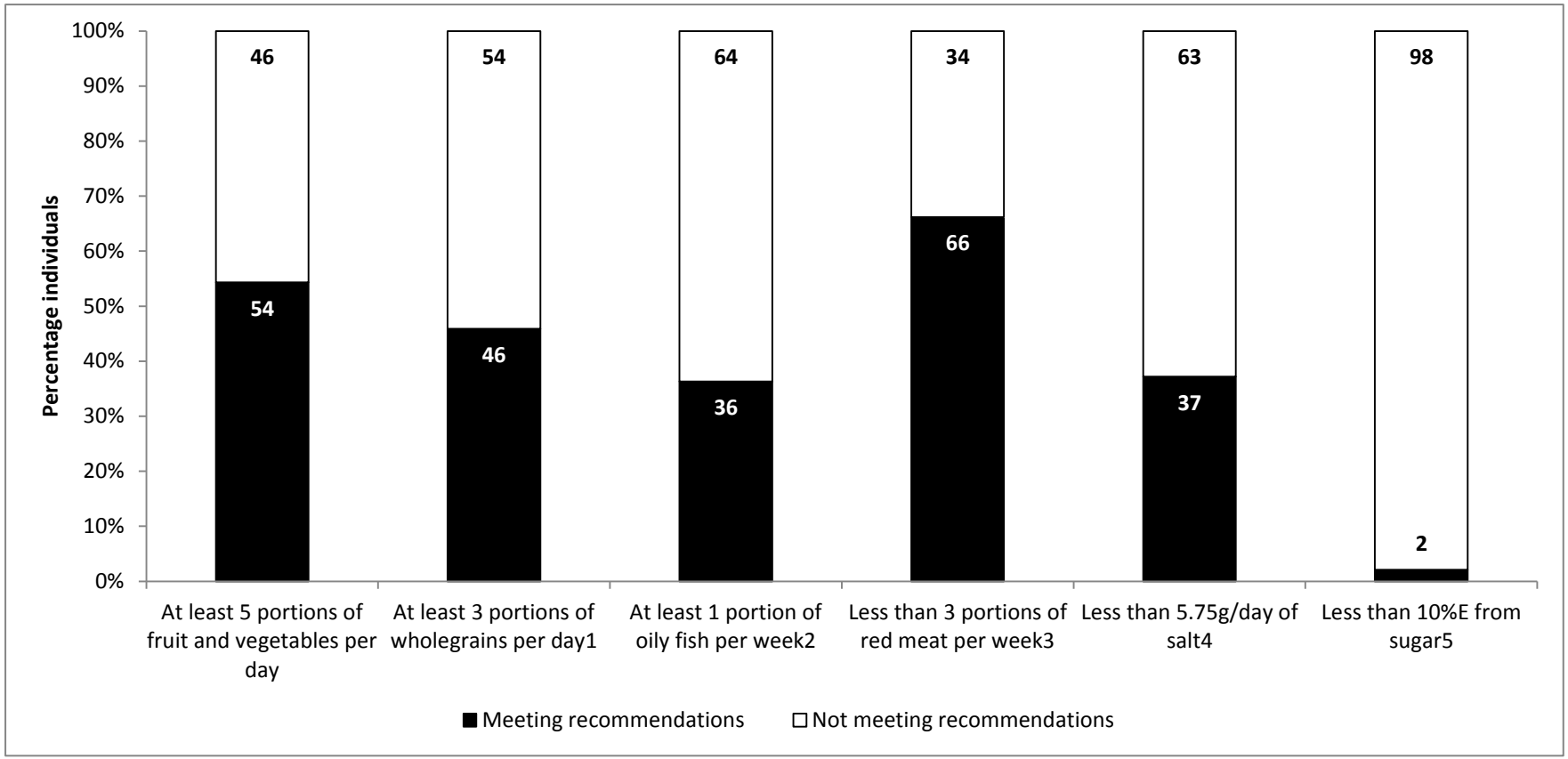
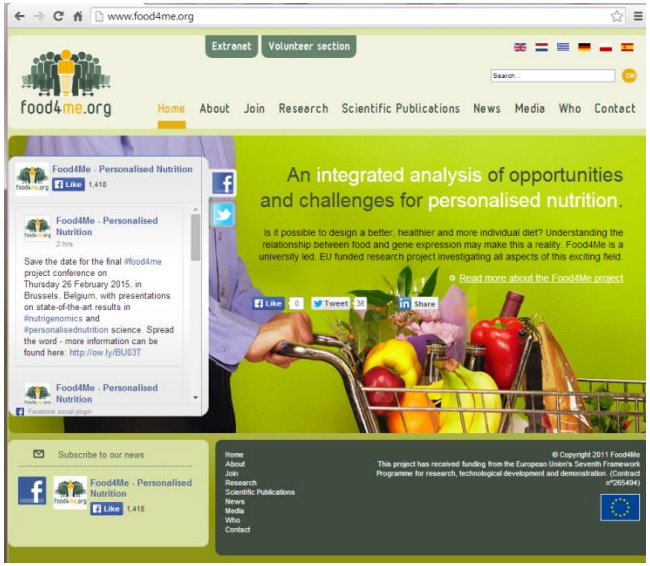


Fig 2. Percentage of participants meeting food-based dietary recommendations.

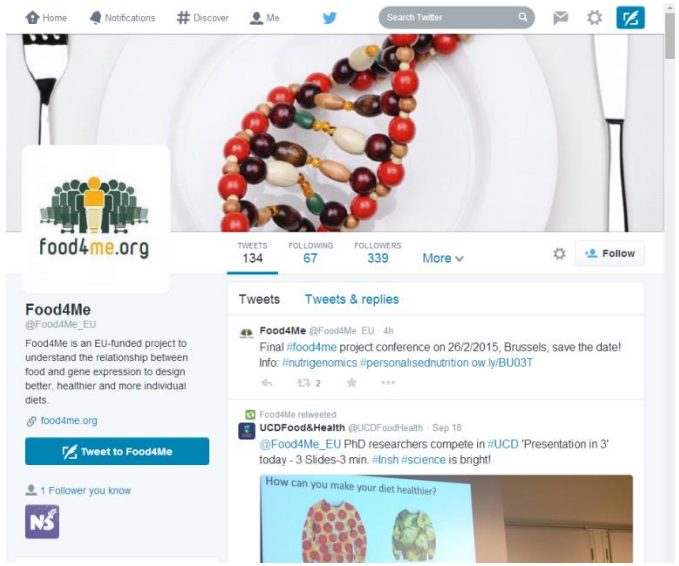
[1]Equivalent to 48g/day; [2]More than 150g/week of oily fish; [3]Consume less than 450g/week of red or processed meat; [4]Based on IoM recommendations[33]; [5]Based on draft Scientific Advisory Committee for Nutrition (SACN) recommendations [27]

Online Resource 1 (Supplementary material)



1.1

1.2



1.3

Figure S1. Screen shots of the Food4Me 1.1 Website; 1.2 Facebook and 1.3 Twitter pages

Figure S2. Examples of UK poster advertisements used during recruitment

Methods: Screening Questionnaires

Unlike in other countries, Dutch individuals had the opportunity to register and then choose whether or not to complete the first screening questionnaire. IP addresses and cookies were not used to identify individuals, as unique usernames prevented participants from entering duplicate entries from the same user and allowed individuals using the same computer, e.g. family members, to register for the study. No monetary incentives were offered for completing the screening questionnaires. Participants were informed that, if they were randomised into the intervention study, they would receive healthy eating and lifestyle advice, as well as non-diagnostic information relating to their health status during, or on completion of, the study. No randomization of adaptive questioning was employed. Automated completeness checks prevented participants from submitting incomplete questionnaire responses. Completion rates were estimated as the ratio of users who finished the survey to users who provided their consent to participate. Once questionnaires were submitted, participants could not change their responses and these responses were later extracted from the server into databases for statistical analysis. Under-reporting of dietary intakes via the FFQ was identified from a comparison between expected energy expenditure, based on a multiple (1.1) of predicted basal metabolic rate and reported energy intakes [34]. Participants who under-reported in their FFQ were asked to repeat the FFQ up to two times before being excluded. Participants had 7 days to complete the screening questionnaires. A reminder was sent at day 5; if they did not complete the screening FFQ by day 7, they were excluded from the study. Individuals who were deemed unsuitable for the study received an email notification that they did not match the inclusion criteria and so were excluded from further elements of the study.

Table S1 Health-related characteristics by sex and age group; data obtained from the second screening questionnaire[1]

	Sex		P	Age		P
	Male	**Female**		**<45**	**≥45**	
Total (n)	1432	2379	-	2395	1416	-
Medication use						
Prescribed	25.0	38.0	<0.001	26.3	44.8	<0.001
Non-prescribed	8.7	13.1	<0.001	9.6	14.5	<0.001
Diseases						
Cancer	1.8	2.6	0.085	1.1	4.3	<0.001
High blood pressure	12.6	7.3	<0.001	3.6	18.9	<0.001
Heart disease	3.4	0.9	<0.001	0.7	3.8	<0.001
Liver disease	2.4	1.2	0.007	1.4	2.1	0.083
Kidney disease	1.1	0.9	0.708	0.7	1.4	0.033
Arthritis	2.1	3.2	0.046	0.8	6.1	<0.001
Osteoporosis	0.6	1.6	0.004	0.3	2.8	<0.001
Ulcers	2.3	1.6	0.114	1.2	3.0	<0.001
Fibromyalgia	0.1	1.1	0.001	0.3	1.5	<0.001
Diabetes	1.2	0.8	0.230	0.4	1.8	<0.001
Lung disease	3.0	2.7	0.519	2.7	2.9	0.742
Allergies	20.9	19.3	0.235	20.7	18.6	0.118
Epilepsy	0.5	0.4	0.759	0.6	0.2	0.095
Thyroid disease	1.5	11.3	<0.001	5.4	11.3	<0.001
Diagnosed anaemia	1.5	9.8	<0.001	6.4	7.2	0.357
Blood disorders	0.8	2.0	0.005	1.8	1.3	0.248
Alcoholism	0.4	0.0	0.008	0.1	0.3	0.060
Drug addiction	0.4	0.1	0.071	0.2	0.3	0.651
Depression	5.2	8.4	<0.001	6.0	9.3	<0.001
Smoker	13.5	12.6	0.417	15.0	9.46	<0.001
Ex-smoker	37.0	33.9	0.083	26.1	49.5	<0.001

[1]Chi squared tests and ANOVA were used to test for significant differences across categorical and continuous variables respectively.

[2]Values are means ± SDs

Table S2 Health-related characteristics of individuals by country; data obtained from the second screening questionnaire[1]

	All	Country						
		UK	IRE	GER	NED	ESP	POL	GRE
Total (n)	3811	413	405	535	511	1206	340	401
Medication								
Prescribed	33.2	30.8	32.6	38.5*	47.4***	28.4**	29.4	28.7
Non-prescribed	11.5	8.5	10.9	16.3**	9.6	10.7	17.9***	8.0*
Clinically diagnosed diseases								
Cancer	2.3	3.2	3.0	2.6	4.5**	1.2*	0.9	1.8
High blood pressure	9.3	5.1**	6.7	9.9	15.3***	9.0	12.9*	5.5
Heart disease	1.9	0.2*	1.2	2.2	3.9**	1.7	3.2	0.5
Liver disease	1.7	0.5	0.7	0.4*	0.6	3.2**	3.2*	0.8
Kidney disease	1.0	0.2	0.5	0.9	0.6	1.5	1.8	0.5
Arthritis	2.8	3.6	4.9*	3.2	3.1	2.0	0.6*	3.0
Osteoporosis	1.2	0.0	1.2	0.8	2.9**	0.8	1.5	1.5
Ulcers	1.9	0.7*	3.0	0.4	1.0	2.1	4.4**	2.5
Fibromyalgia	0.8	0.7	0.5	0.4	1.8*	0.8	0.3	0.5
Diabetes	0.9	0.5	0.5	0.6	1.8	0.8	0.9	1.8
Lung disease	2.8	1.0*	0.7*	1.7	5.5**	3.1	2.9	3.7
Allergies	19.9	15.3*	13.3**	20.6	18.8	26.9***	14.1*	15.7*
Epilepsy	0.5	0.5	0.5	0.8	0.4	0.6	0.0	0.0
Thyroid disease	7.6	4.8*	3.7**	11.6**	4.3**	5.7*	9.1	11.6**
Diagnosed anaemia	6.7	6.1	3.2**	0.6***	9.8*	8.3	8.8	8.7
Blood disorders	1.6	1.0	1.0	0.4*	0.6	2.3	2.9	2.2
Alcoholism	0.2	0.2	0.0	0.4	0.6	0.0	0.0	0.3
Drug addiction	0.2	0.5	0.0	0.0	0.4	0.0	0.0	0.5
Depression	7.2	12.6***	9.9	3.6**	8.0	7.6	2.7**	5.2
Smoker	12.9	5.6***	8.9*	9.0*	6.9***	16.5**	8.8*	30.2***
Ex-smoker	35.1	20.6***	30.3	37.4	48.5***	39.4*	19.2***	31.8

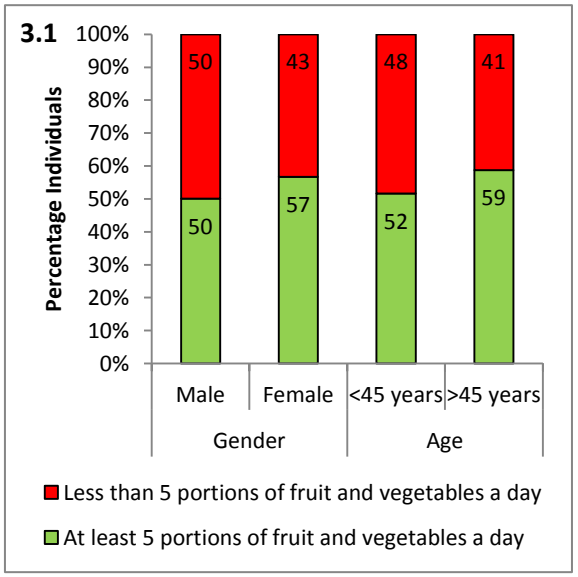
[1]Multinomial regression analyses were used to test for significant differences across categorical variables. For multinomial comparisons across countries, the overall average was used as the reference group. ANOVA and Fisher-Hayter pairwise comparisons were used for continuous variables. Results were deemed significant at * P<0.05, ** P<0.01 and *** P<0.001.

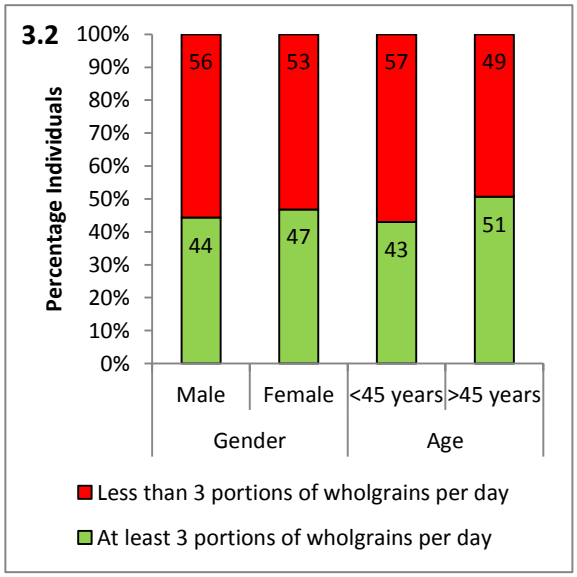
[2]Values are means ± SDs

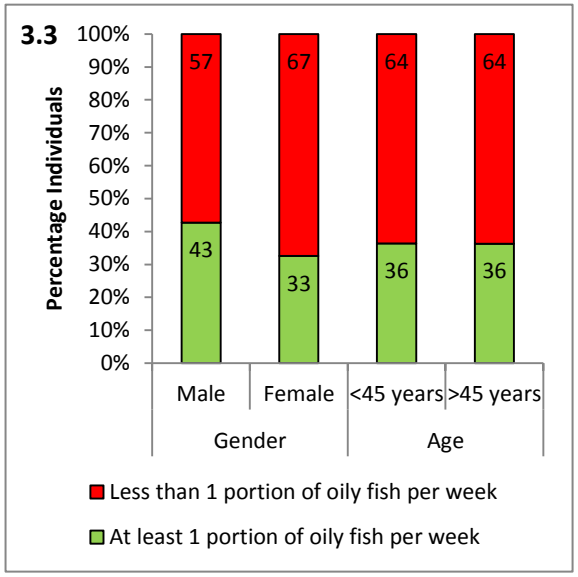
Table S3. Mean intakes of key foods and food groups[1]

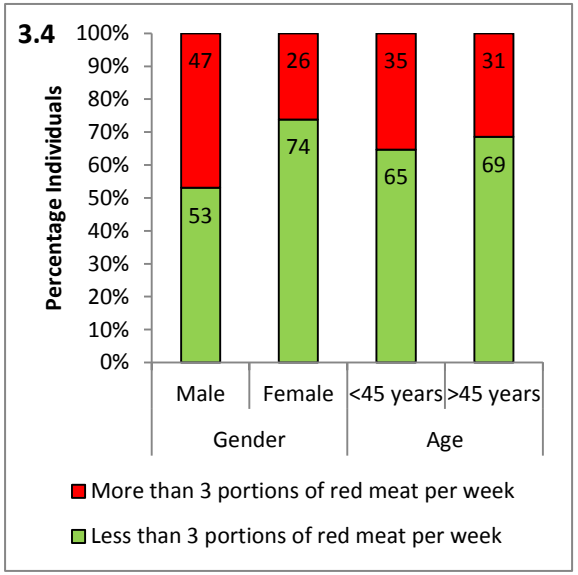
Dietary target	Fruit and vegetables	Wholegrain products	Oily fish	Red meat	Salt	Sugars
	g/day (SD)	g/day (SD)	g/week (SD)	g/week (SD)	g/day (SD)	% energy (SD)
All	651.4 (488.6)	173.0 (208.5)	171.0 (236.3)	573.0 (516.9)	7.56 (4.9)	21.4 (6.6)
Sex						
Male	645.2 (410.8)	188.6 (237.7)	200.0 (237.2)	713.0 (597.3)	8.56 (4.79)	20.4 (6.3)
Female	655.0 (528.7)	163.9 (188.8)	154.2 (234.2)	491.4 (443.8)	6.97 (4.83)	21.4 (6.6)
P	0.611	0.003	<0.001	<0.001	<0.001	<0.001
Age category						
<45 years	633.4 (519.6)	156.7 (198.9)	169.8 (222.8)	594.5 (548.4)	7.64 (4.50)	21.5 (6.5)
≥45 years	681.3 (430.5)	200.2 (220.9)	173.1 (257.5)	537.2 (457.5)	7.43 (5.45)	21.2 (6.6)
P	0.013	<0.001	0.719	0.005	0.272	0.238
Country						
UK	687.0 (425.3)	176.2 (192.5)	168.2 (191.6)	466.7 (392.2)*	7.3 (4.1)	22.9 (6.4)*
Ireland	696.7 (881.9)	222.7 (152.8)*	163.0 (224.7)	592.4 (492.0)	7.7 (3.70)	21.3 (6.3)
Germany	675.8 (398.4)	182.2 (161.6)	104.9 (142.6)*	445.1 (599.3)*	6.9 (4.1)	21.6 (6.3)
The Netherlands	647.5 (351.3)	319.2 (290.2)*	152.0 (213.8)	482.3 (445.8)*	8.3 (4.4)*	20.6 (6.1)
Spain	641.8 (419.9)	73.6 (110.6)*	260.3 (249.8)*	746.1 (537.3)*	7.9 (6.3)	21.3 (6.9)
Poland	595.8 (436.8)	214.9 (268.7)*	132.8 (176.9)	536.1 (538.7)	8.2 (4.8)	21.8 (7.0)

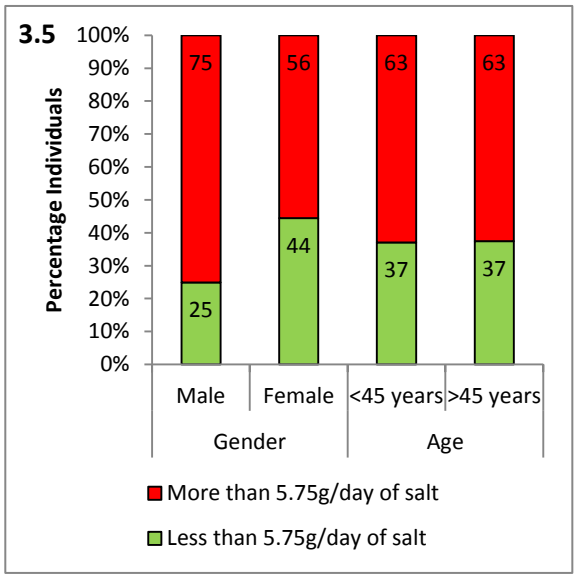
[1]Multinomial regression analyses were used to test for significant differences across categorical variables. For multinomial comparisons across countries, the overall average was used as the reference group. ANOVA and Fisher-Hayter pairwise comparisons were used for continuous variables. Results across countries were deemed significant at * P<0.05


3.1
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
50
43
48
41
50
57
52
59
Male
Female
<45 years
>45 years
Gender
Age
Less than 5 portions of fruit and vegetables a day
At least 5 portions of fruit and vegetables a day


3.2
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
56
53
57
49
44
47
43
51
Male
Female
<45 years
>45 years
Gender
Age
Less than 3 portions of wholgrains per day
At least 3 portions of wholgrains per day


3.3
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
57
67
64
64
43
33
36
36
Male
Female
<45 years
>45 years
Gender
Age
Less than 1 portion of oily fish per week
At least 1 portion of oily fish per week


3.4
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
47
26
35
31
53
74
65
69
Male
Female
<45 years
>45 years
Gender
Age
More than 3 portions of red meat per week
Less than 3 portions of red meat per week


3.5
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
75
56
63
63
25
44
37
37
Male
Female
<45 years
>45 years
Gender
Age
More than 5.75g/day of salt
Less than 5.75g/day of salt

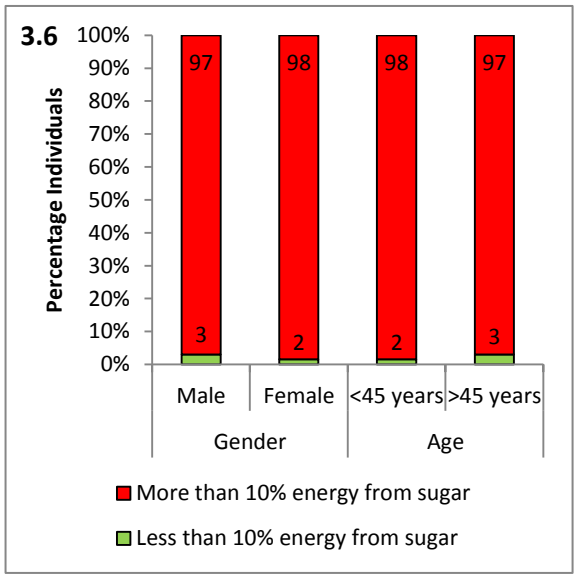

3.6
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Individuals
97
98
98
97
3
2
2
3
Male
Female
<45 years
>45 years
Gender
Age
More than 10% energy from sugar
Less than 10% energy from sugar

Figure S3. Percentage of individuals meeting the dietary recommendations for 3.1 At least 5 portions of fruit and vegetables a day (400g/day); 3.2 At least 3 portions of whole grain per day (48g/day); 3.3 At least 1 or more servings of oily fish per week (150g/week); 3.4 Less than 3 portions of red or processed meat per week (450g/week); 3.5 Less than 5.75g salt per day; 3.6 Less than 10% energy from sugars by age and sex.

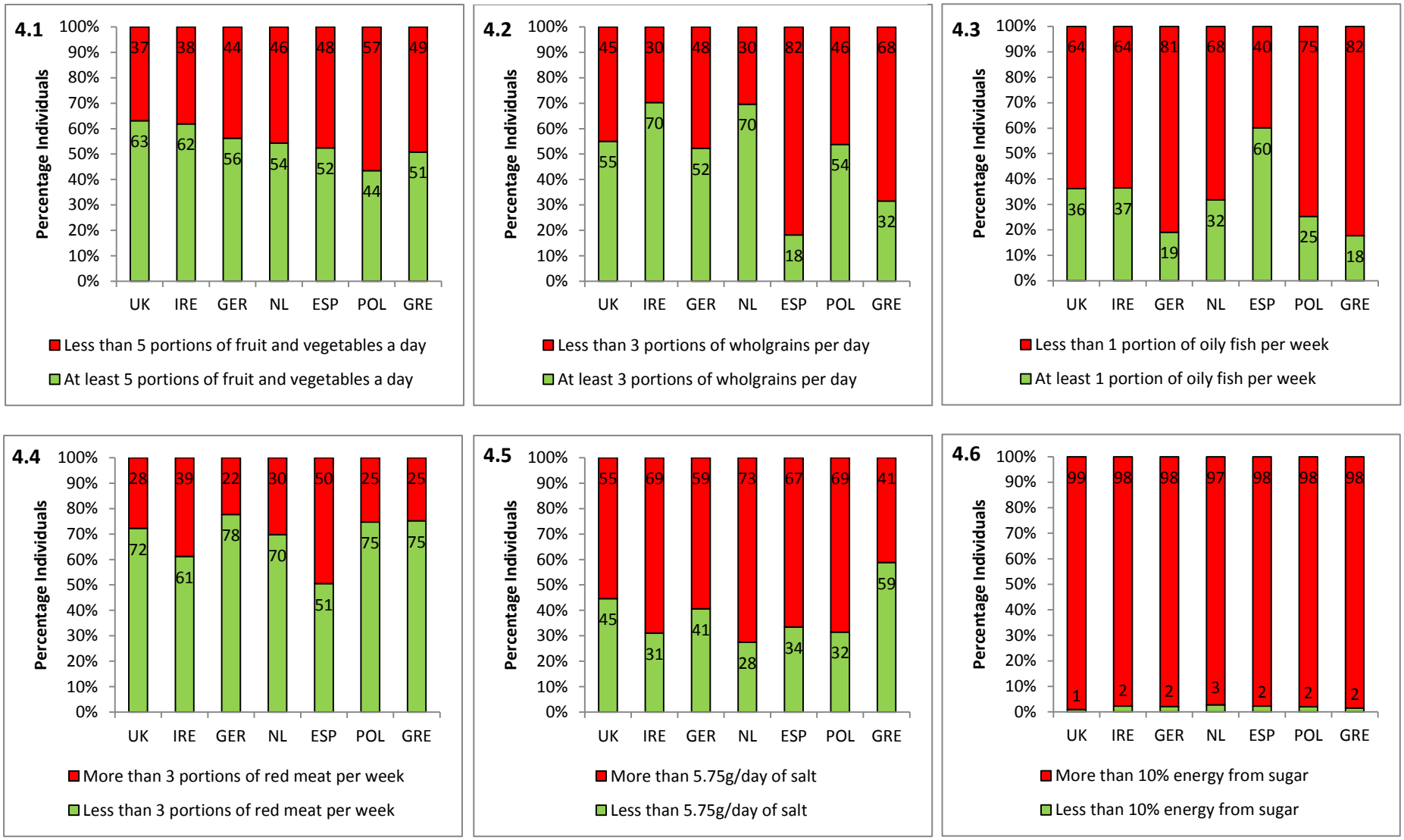


Figure S4. Percentage of individuals meeting the dietary recommendations for 4.1 At least 5 portions of fruit and vegetables a day (400g/day); 4.2 At least 3 portions of whole grain per day (48g/day); 4.3 At least 1 or more servings of oily fish per week (150g/week); 4.4 Less than 3 portions of red or processed meat per week (450g/week); 4.5 Less than 5.75g salt per day; 4.6 Less than 10% energy from sugars by country

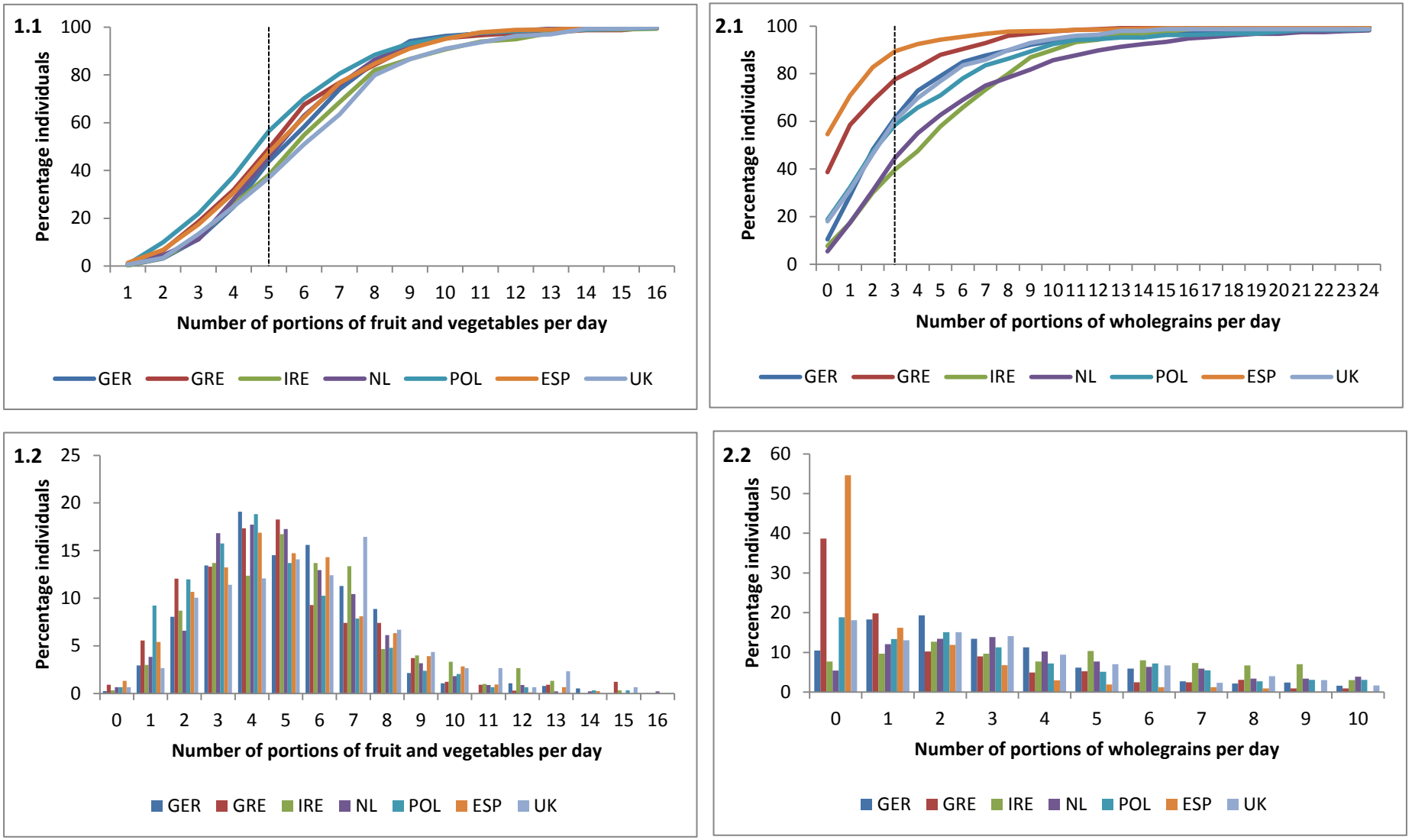
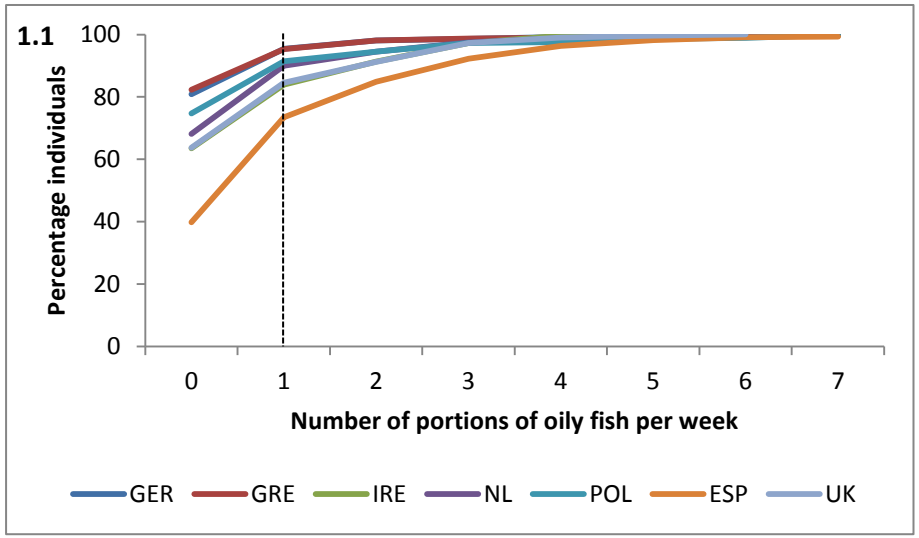
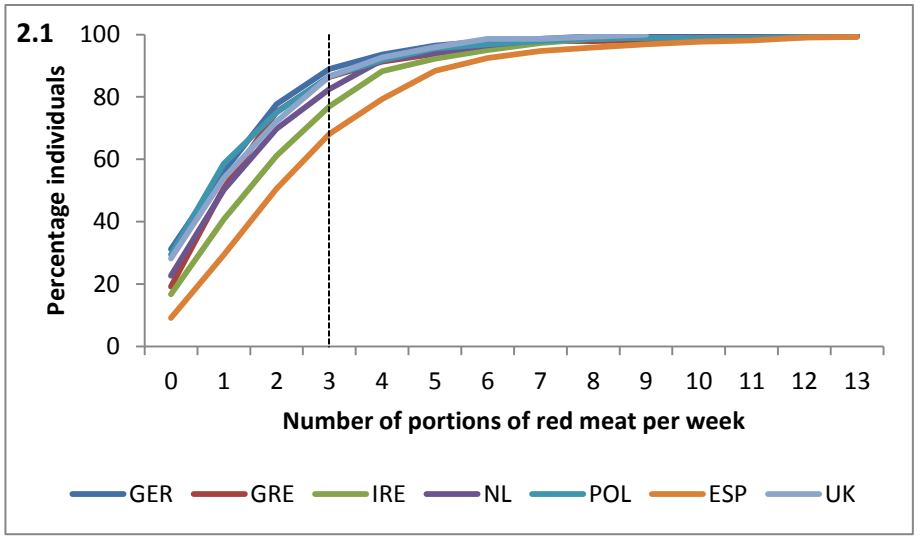
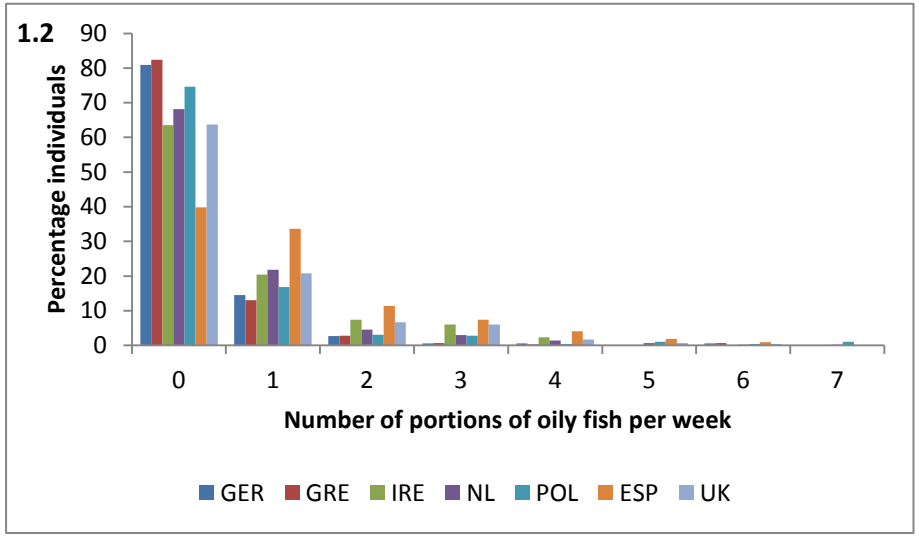


Figure S5. Cumulative (.1) and relative percentage (.2) of portion consumption of 1 fruit and vegetables and 2 wholegrain by country. The recommended number of portions is indicated by the dotted line.







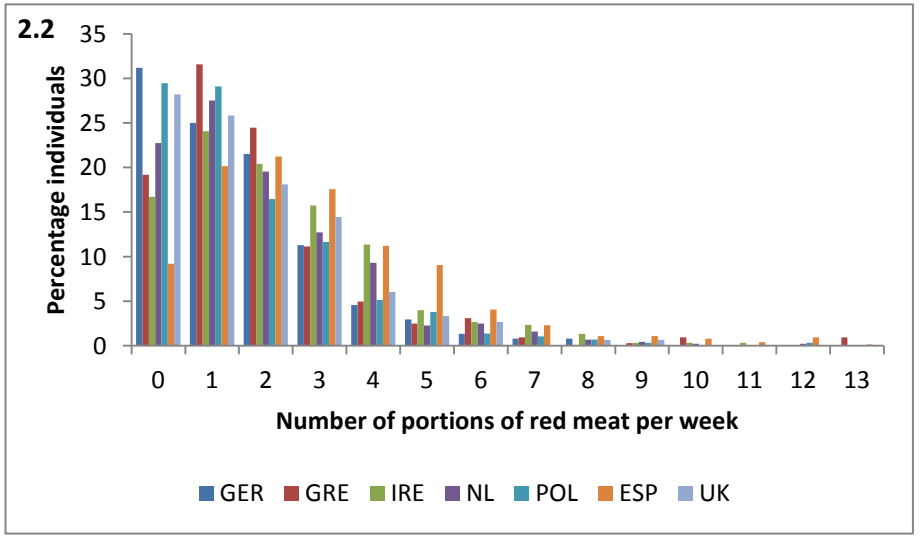


Figure S6. Cumulative (.1) and relative percentage (.2) of portion consumption of 1 fruit and vegetables and 2 wholegrain by country. The recommended number of portions is indicated by the dotted line.